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IS : 7440 (Part III/Sec 2) - 1977
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Indian Standard

ESSENTIAL RATINGS AND CHARACTERISTICS OF ANALOGUE INTEGRATED CIRCUITS

PART III OPERATIONAL AMPLIFIER

Section 2 Having Two Inputs and Two Outputs

UDC 621·375·4:621·3·02

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ESSENTIAL RATINGS AND CHARACTERISTICS OF ANALOGUE INTEGRATED CIRCUITS

PART III OPERATIONAL AMPLIFIER

Section 2 Having Two Inputs and Two Outputs

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Indian Standard

ESSENTIAL RATINGS AND CHARACTERISTICS OF ANALOGUE INTEGRATED CIRCUITS

PART III OPERATIONAL AMPLIFIER

Section 2 Having Two Inputs and Two Outputs

0. FOREWORD

0.1 This Indian Standard (Part III/Section 2) was adopted by the Indian Standards Institution on 20 April 1977, after the draft finalized by the Semiconductor Devices and Integrated Circuits Sectional Committee had been approved by the Electronics and Telecommunications Division Council.

0.2 This standard (Part III/Section 2) deals with the essential ratings and characteristics and other information to be specified for operational amplifiers having two inputs and two outputs. This standard should be used in conjunction with IS : 3700 (Part I)-1972* and IS : 7440 (Part I)-1974† covering format and the general requirements.

0.3 The object of this standard is to specify clearly the properties of the device for the intended application and to facilitate comparison and choice between similar products. It is anticipated that adoption of this standard will ensure uniformity in the presentation of device data as well as certain minimum information on these essential ratings, characteristics and other parameters of the device covered.

0.3.1 While the lists of ratings and characteristics have been kept at their minimum, a manufacturer may always give additional information at his discretion.

0.4 This standard is based on the IEC Pub 147-IE (1973) Fifth supplement to Pub 147-1 (1972) 'Essential ratings and characteristics of semiconductor devices and general principles of measuring methods, Part 1 Essential ratings and characteristics, issued by the International Electrotechnical Commission.

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*Essential ratings and characteristics of semiconducter devices: Part I General (*first revision*).

†Essential ratings and characteristics of analogue integrated circuits: Part I General format.

0.5 This standard is one of a series of Indian Standards on semiconductor devices and integrated circuits. A list of standards so far prepared in this series is given on page 12.

0.6 In reporting the results of measurements made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard (Part III/Sec 2) covers essential ratings and characteristics and other information to be specified in the case of operational amplifiers having two inputs and two outputs.

2. TERMINOLOGY, GRAPHICAL SYMBOLS AND LETTER SYMBOLS

2.1 The provisions of **2** of IS : 3700 (Part I)-1972† shall apply.

3. ASSIGNED TYPE NUMBER

3.1 A type number shall be assigned for identification of the device. The number shall be prominently displayed on the device.

4. DESCRIPTION OF THE INTEGRATED CIRCUIT

4.1 Information on the following, as required in IS : 3700 (Part I)-1972†, shall be furnished:

a) The category of the integrated circuit namely analogue integrated circuit;

b) Function of the circuit — a general description of the function performed by the analogue integrated circuit;

c) Technique used in the manufacture such as bipolar, MOS, thin film, etc;

d) Constructional details such as monolithic, hybrid, etc; and

e) Material such as silicon.

5. OUTLINES AND CONNECTIONS

5.1 Details of Outline and Encapsulation — The following information shall be given:

a) Reference to the outline covered in relevant part of IS : 5000‡ or an outline drawing showing essential dimensions and tolerances, location of terminals and other information;

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*Rules for rounding off numerical values (*revised*).

†Essential ratings and characteristics of semiconductor devices: Part I General (*first revision*).

‡Dimensions of semiconductor devices.

b) Method of encapsulation; and

c) Marking (the drawing of the case with the marking should be reproduced).

6. BLOCK DIAGRAM AND TERMINAL CONNECTIONS

6.1 The block diagram and the identification of the connections should be shown. When the encapsulation has metallic parts, any connection to them from external terminals should be indicated. The connections with any associated external electrical elements should also be stated.

6.2 As an additional information, the complete electrical diagram may be reproduced, including significant parasitic elements, but not necessarily with indications of the values of the circuit components.

7. RATINGS (LIMITING VALUES)

7.1 Electrical Ratings — The following ratings for voltages and currents shall be specified under conditions mentioned against each:

a) *Power Supply Voltage(s)*

  1) Maximum value(s) and polarities;
  2) Maximum permissible ripple on the supply voltage(s);
  3) Maximum values of transients or spurious signals from the supplies for a specified time duration;
  4) Maximum value of the permitted voltage between a common supply terminal and case or reference terminal, where appropriate; and
  5) The sequence of the application of supply voltages, where appropriate.

b) *Power Supply Current(s)*

  1) Maximum values, where appropriate; and
  2) Maximum values for a specified duration (external fault conditions), where appropriate.

c) *Input Terminal Voltages*

  1) Maximum values, with respect to a common reference terminal, including bias voltages; and
  2) Maximum value between input terminals.

d) *Output Terminal Voltages*

  1) Maximum values, with respect to a common reference terminal, including bias voltages; and
  2) Maximum value between output terminals.

e) *Input Terminal Currents* — Maximum values, including bias currents.

f) *Output Terminal Currents* — Maximum values, including bias currents.

g) *Impedances* — Maximum values for impedances of the supplies to which the circuit is connected, where appropriate.

7.2 Temperature Ratings — The following temperature ratings shall be specified:

a) *Operating Temperatures* — Minimum and maximum values of ambient or reference point operating temperature.

b) *Storage Temperatures* — Minimum and maximum values.

7.3 Power Dissipation Ratings — Where appropriate, maximum value of power dissipation ratings over the operating temperature range for given mounting conditions shall be stated.

7.4 Short Circuit Conditions — Where appropriate, maximum duration of short circuit between terminals or between terminals and ground shall be specified.

7.5 Mechanical Ratings — The mechanical ratings shall be specified in accordance with **9.1** of IS : 3700 (Part I)-1972*.

8. RECOMMENDED OPERATING CONDITIONS

8.1 The recommended operating conditions within the specified operating temperature range of the following shall be stated:

a) *Power Supplies* — The polarities, the values and tolerances for voltages or currents and for impedances. Wherever possible, the voltages should be chosen from the list of preferred values given in IS : 7440 (Part I)-1974†.

b) *Supply Current(s)* — Nominal value(s).

c) *Impedance* — Maximum value(s) of the supplies, where appropriate.

d) *Input Terminals*

  1) Value(s) of the voltage(s) or current(s) or both of the input signal or of the signal generator.

  2) Value(s) of the bias on the input terminals, where appropriate.

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*Essential ratings and characteristics of semiconductor devices: Part I General (*first revision*).

†Essential ratings and characteristics of analogue integrated circuits: Part I General format.

e) *Output Terminals*
   1) Nominal value(s) of the voltage(s) or current(s) or both of the output signal and of the load impedance.
   2) Value(s) of the bias on the output terminals, where appropriate.

f) *External Elements* — Value(s) and tolerance(s) for the external element(s) which shall be associated with the circuit.

8.1.1 The variation of the parameters specified in **8.1** *versus* temperature should also be stated over the specified temperature range, where appropriate.

9. ELECTRICAL CHARACTERISTICS

9.0 General — The electrical characteristics shall be stated at the reference point or ambient temperature of 25°C, the specific electrical conditions under which the device operates being also stated.

9.1 Power Consumption — Typical value of the power consumption shall be stated.

9.2 Input Characteristics — The following characteristics shall be stated:

a) *Input Admittances/Impedances* — Minimum and maximum values for specified values of:

   load impedance,
   measuring frequency, and
   input signal amplitude.

b) *Magnitude of Input Offset Voltage and Current* — Maximum values for specified values of source resistance, if they affect the values of these characteristics.

c) *Input Bias Current* — A maximum value for zero or specified voltage in common mode.

d) (*Equivalent*) *Input Drift* — Maximum value under specified conditions.

e) *Common Mode Rejection Ratio* — It is defined as the ratio of input voltage range to the maximum change in input offset voltage over this range. Maximum and typical values at specified values of:
   1) supply voltage(s),
   2) output voltage with zero input signal in common mode,
   3) load and source impedances,
   4) frequency of the input signal,
   5) amplitude of input signal in common mode, and
   6) adjustment of the gain control (if it exists).

f) *Input Offset Voltage* — The voltage which shall be applicable between input terminals to obtain zero differential output voltage.

9.3 Output Characteristics — The following characteristics shall be stated:

a) *Output Resistance* — The resistance seen looking into either output terminals with differential output at zero. Minimum or maximum values or both for specified values of the following:

  1) Supply voltages,
  2) Source impedance,
  3) Frequency, and
  4) Output signal amplitude.

b) *Differential Output Voltage Swing* — The peak differential output swing that may be obtained without clipping. Typical and minimum values for specified supply voltage and load resistance and, where appropriate, for a specified value of total distortion.

c) *Maximum Rate of Change of Differential Output Voltage* (*for Large Signal Operation*) — Typical and, where appropriate, minimum value(s) under specified conditions.

NOTE — The rise and/or fall time of the input pulse should be at least one order less compared to the slope time of the operational amplifier.

d) *Output Common Mode Voltage* — Average voltage at the two output terminals referred to ground.

e) *Differential Load Rejection* — The ratio of input offset voltage to change in differential load current producing it.

f) *Output Sink Current* — The maximum negative current that may be supplied by each output.

g) *Differential Distortion* — AC unbalanced voltage in common mode output voltage produced by unsymetrical voltage swing.

9.4 Forward Transfer Characteristics — The following characteristics shall be stated:

a) *Open Loop Gain* — Maximum and minimum value for specified values of the following:

  1) Supply voltage(s),
  2) Frequency,
  3) Adjustment of the gain control (if it exists),
  4) Load and source impedance(s), and
  5) Amplitude of the output signal at which the gain is measured.

b) *Operation with Sinusoidal Signals* — Maximum or minimum values or both for one or more of the following characteristics shall be stated:

   1) Frequency for which the open loop differential gain has decreased by 3 dB from its low frequency value, and
   2) Frequency for the unity gain.

c) *Differential Voltage Gain* — The ratio of the change in differential output voltage to the change in differential input voltage producing it.

9.5 Noise (where appropriate) — A maximum value should be stated.

NOTE — The noise should be specified in terms of noise factor or in terms of equivalent rms input voltage or current or both, for specified values of supply voltage(s), source resistance, frequency and bandwidth.

9.6 Interaction Between the Amplifier and the Supply Lines — The following shall be stated for appropriate specified conditions both for steady state and transient conditions:

a) Maximum signal from the amplifier appearing on the supply lines (where appropiate),

b) The transfer characteristic from the supplies referred to the input of the amplifier, and

c) The impedance of the amplifier at the supply terminals (where appropriate).

9.7 Differential Step Response

9.7.1 The differential step response shall be specified in terms of the following:

a) Delay time: t_d

b) Slope time: t_s (t_r or t_f)

c) Ripple time: t_{rip}

d) Total response time: t_{tot}

NOTE — For the purpose of essential characteristics only three of these four parameters have to be stated (*see* Fig. 1).

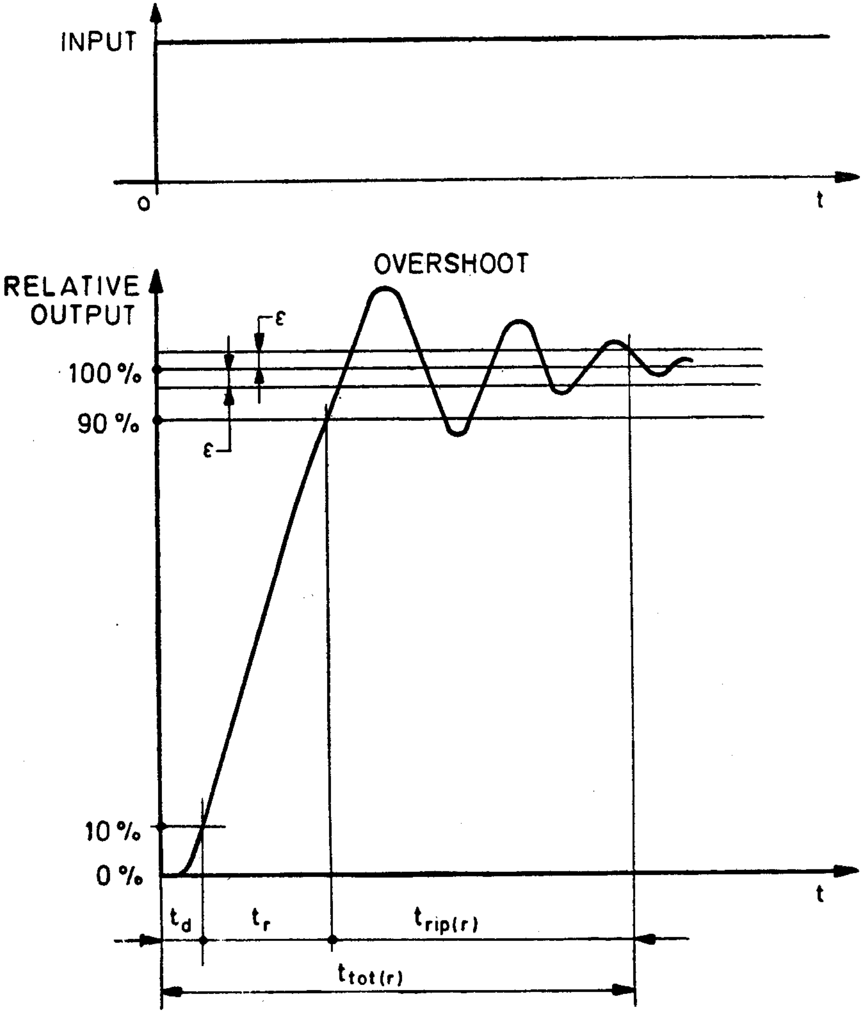
The characteristic values of these parameters should be stated as typical and where appropriate as maximum value(s) under the following specified conditions:

1) Unity gain configuration,

2) Input and feedback resistance values with which unity gain configuration is realized,

3) Phase compensating conditions (configuration and values of the compensating networks, if any), and
4) Load conditions (configuration and values of the loading network).

NOTE — The rise time of the input pulse should be at least one order less compared to any of the response times of the operational amplifier.



ε = Specified percentage of the final (quiescent) value.

FIG. 1 EXAMPLE OF RESPONSE TIMES OF LINEAR AMPLIFIERS

9.8 Overshoot Factors — Maximum value for the same specified conditions as the response times should be stated.

9.9 Effects of Variation of Supply Voltage(s) and Temperature on the Electrical Characteristics — Where appropriate the effects of variation of supply voltage and temperature on the essential characteristics specified in **9.1** to **9.8** shall be stated over the recommended operating conditions of temperature and supply voltages as specified in **8**.

10. MECHANICAL CHARACTERISTICS AND OTHER DATA

10.1 Mechanical characteristics and other data required for the detailed mechanical design, assembly precautions, etc, should be supplied as specified in **9.2** and **9.3** of IS : 3700 (Part I)-1972*.

11. ENVIRONMENTAL DATA

11.1 Where appropriate, the relevant environmental data shall be stated in accordance with IS : 6553-1971†.

12. RELIABILITY DATA — Under consideration.

13. CHARACTERISTICS CURVES

13.1 Graphical representation of the relevant characteristic curves of the integrated circuits as given in **9.9**, shall be provided.

14. ADDITIONAL INFORMATION

14.1 A curve of the typical variation of input and output impedances or admittances versus frequency, the other specified conditions remaining unchanged shall also be given.

14.2 Any external elements to be associated with the integrated circuit should be referred to its terminals. These external elements should appear in two distinct tables as follows:

a) The first table should include the associated elements which are specific to a function, or which determine an operation.

b) The second table should include the associated elements which serve as correcting elements.

14.2.1 Each table should include the following three columns:

a) In the first column, the circuit terminals concerned should be identified.

b) In the second column, the nature of the external elements concerned should be indicated (for example: RC network).

c) In the third column, the resulting effect of the circuit together with the external element should be indicated.

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*Essential ratings and characteristics of semiconductor devices: Part I General (*first revision*).

†Environmental requirements for semiconductor devices and integrated circuits.

INDIAN STANDARDS ON SEMICONDUCTOR DEVICES

IS:

- 1885 (Part VII) Electrotechnical vocabulary: Part VII Semiconductor devices;
  - (Sec 1)-1970 General
  - (Sec 2)-1970 Diodes
  - (Sec 3)-1970 Transistors
  - (Sec 4)-1969 Thyristors
  - (Sec 5)-1971 Integrated circuits and microelectronics
- 2032 (Part VIII)-1965 Graphical symbols used in electrotechnology: Part VIII Semiconductor devices
- 3700 Essential ratings and characteristics of semiconductor devices:
  - (Part I)-1972 General (*first revision*)
  - (Part II)-1972 Low power signal diodes (*first revision*)
  - (Part III)-1973 Rectifier diodes (*first revision*)
  - (Part IV)-1968 Low power small signal transistors
  - (Part V)-1968 Power transistors
  - (Part VI)-1968 Switching transistors
  - (Part VII)-1970 Reverse blocking triode thyristors
  - (Part VIII)-1970 Voltage regulator and voltage reference diodes
  - (Part IX)-1972 Variable capacitance diodes
- 3715 Letter symbols for semiconductor devices:
  - (Part I)-1971 General aspects
  - (Part II)-1971 Diodes
  - (Part III)-1971 Transistors
  - (Part IV)-1971 Thyristors
- 4400 Methods of measurements on semiconductor devices:
  - (Part I)-1967 General
  - (Part II)-1967 Low power signal diodes
  - (Part III)-1968 Rectifier diodes
  - (Part VII)-1971 Reverse blocking triode thyristors
  - (Part VIII)-1970 Voltage regulator and voltage reference diodes
  - (Part IX) Variable capacitance diodes
    - (Sec 1)-1974 For operating frequencies below 300 MHz
    - (Sec 2)-1974 For operation at frequency above 6 GHz
- 4411-1967 Code for designation of semiconductor devices
- 5000 Dimensions of semiconductor devices

  NOTE — Standards on dimensions of semiconductor devices are published in loose leaf form (individually priced) and are supplied in an attractive binder (priced separately). So far 31 standards have been published.

- 5001 Guide for preparation of drawings of semiconductor devices and integrated circuits:
  - (Part I)-1969 Semiconductor devices
  - (Part II)-1973 Integrated circuits
- 5469 Code of practice for the use of semiconductor junction devices:
  - (Part I)-1969 Applicable to all devices
  - (Part II)-1973 Diodes
  - (Part III)-1973 Thyristors
- 6553-1971 Environment requirements for semiconductor devices and integrated circuits
- 7412-1964 Life testing semiconductor devices
- 7440 (Part I)-1974 Essential ratings and characteristics of analogue integrated circuits: Part I General format
- 7440 (Part II)-1974 Essential ratings and characteristics of analogue integrated circuits: Part II Telecommunication amplifiers audio, video and multichannel
- 7440 (Part III/Sec 1)-1976 Essential ratings and characteristics of analogue integrated circuits: Part III Operational amplifier, Section 1 Having two inputs and one output
- 7440 (Part III/Sec 2)-1977 Essential ratings and characteristics of analogue integrated circuts: Part III Operational analogue, Section 2 Having two inputs and two outputs
- 7441 (Part I)-1974 Essential ratings and characteristics of digital integrated circuits: Part I General format